

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
5 August 2004 (05.08.2004)

PCT

(10) International Publication Number  
**WO 2004/065811 A1**

(51) International Patent Classification<sup>7</sup>: **F16D 41/04**,  
F02N 15/02

(21) International Application Number:  
PCT/NL2004/000052

(22) International Filing Date: 22 January 2004 (22.01.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
1022458 22 January 2003 (22.01.2003) NL

(71) Applicant (for all designated States except US): **AB SKF**  
[SE/SE]; Hornsgatan 1, S-415 50 Göteborg (SE).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **VAN LEEUWEN, Bernardus, Gerardus** [NL/NL]; Prof. Dr. Bakkerlaan 3, NL-3431 EG Nieuwegein (NL). **GIRARDIN, Carole** [FR/FR]; 4, Rue de la Croix de St. Jean, F-37390 Charentilly (FR). **MCFARLAND, Craig, James** [CA/CA]; 4608 - 33rd Avenue South West, Calgary, Alberta T3E 0Y7 (CA).

(74) Agents: **VAN WESTENBRUGGE, Andries** et al.; Nederlandsch Octrooibureau, Scheveningseweg 82, P.O. Box 29720, NL-2502 LS The Hague (NL).

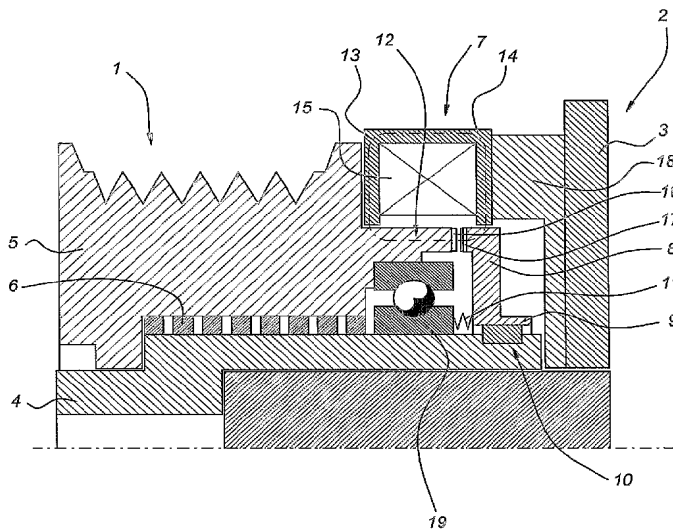
(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:  
— with international search report

[Continued on next page]

(54) Title: CLUTCH DEVICE AND STARTER/GENERATOR COMPRISING SUCH CLUTCH DEVICE



(57) Abstract: A pulley device comprises a shaft (4), a pulley (5) which is rotatably mounted on said shaft, and a one-way clutch (6) for providing a freely rotatable condition when the shaft and the pulley are rotated with respect to each other in a first relative rotational direction, and for providing a fixation between the shaft and the pulley when they are rotated with respect to each other in the opposite relative rotational direction. A locking clutch (7) provides a fixation between the shaft and the pulley, said locking clutch preventing mutual rotations between the shaft and the pulley in both relative rotational directions.

WO 2004/065811 A1



---

*For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.*

Clutch device and starter/generator comprising such clutch device

The invention is related to a clutch device, comprising a shaft, a rotation member, such as a pulley, which is coaxially mounted on said shaft, and a one-way clutch for  
5 providing a freely rotatable condition when the shaft and the rotation member are rotated with respect to each other in a first relative rotational direction, and for providing a fixation between the shaft and the rotation member when they are rotated with respect to each other in the opposite relative rotational direction.

Such a clutch device is known. It is applied in several fields, for instance in  
10 connection with a generator for an internal combustion engine. In case the generator is coupled to the engine through a belt drive, variations in the engine torque cause belt vibrations and hence a reduction in belt life. As a result of the one-way clutch in the clutch device however, the transmission of vibrations from the engine, e.g. due to engine acyclism, is reduced. The reverse torque resulting from such phenomena is  
15 limited, which has a favourable effect on belt behaviour.

The prior art device however has the disadvantage that it cannot be applied in combination with a combined starter and generator. The one-way clutch in fact prevents to transmit the starter torque to the engine, as it allows a free relative rotation in the drive direction of the starter. The object of the invention is therefore to provide a  
20 clutch device which can also be applied in connection with a combined starter and generator.

Said object is achieved by a means of a locking clutch for providing a fixation between the shaft and the rotation member, said locking clutch preventing mutual rotations between the shaft and the pulley in both relative rotational directions. For  
25 engine starting the locking clutch is engaged, effectively disabling the one-way clutch, allowing torque to be transmitted from the starter/generator device acting as a starter to the engine. Once the engine is started, said locking clutch can be disengaged, which then enables operation of the one way clutch, allowing the transmission of torque from the engine to the starter/generator device now acting as generator, but preventing the  
30 transmission of torque from the starter/generator device to the engine, thereby preventing belt vibration due to engine acyclism.

Preferably, the locking clutch is of an electromagnetic type. The locking clutch may comprise a first armature which is axially slidably and rotationally fixed to the

shaft or the rotation member, and a second armature which is fixedly connected to the other of said shaft and rotation member. The coupling means of these said armatures may be provided by either friction plates or meshing teeth.

According to a particular embodiment, the clutch device comprises a locking  
5 clutch for providing a fixation between the shaft and the rotation member, said locking clutch, when engaged, enabling direct torque transmission from the shaft to the rotation member, the one-way clutch being disabled.

The invention is furthermore related a belt driven starter/generator device, comprising a starter/generator provided with a housing, a stator connected to the  
10 housing, and a rotor having a rotor shaft rotatably supported with respect to the housing, as well as a clutch device as described before, said clutch device comprising a rotation member which is rotatably mounted on the rotor shaft, and a one-way clutch for providing a freely rotatable condition when the rotor shaft and the rotation member are rotated with respect to each other in a first relative rotational direction, and for  
15 providing a fixation between the rotor shaft and the rotation member when they are rotated with respect to each other in the opposite relative rotational direction, as well as a locking clutch for providing a fixation between the rotor shaft and the rotation member, said locking clutch preventing mutual rotations between the rotor shaft and the rotation member in both relative rotational directions.

20 Said locking clutch comprises a first armature which is axially slidably and rotationally fixed to the shaft or the rotation member, a second armature which is fixedly connected to the other of said shaft and rotation member, an electromagnetic coil connected to the housing for generating a electromagnetic flux under the influence of which the armatures are attracted towards each other as well as coupling means  
25 associated with said armatures, said coupling means engaging each other when the electromagnetic coil is energized.

The rotation member at its side facing the housing carries the second armature, and the electromagnetic coil extending next to said second armature. The electromagnetic coil is comprised of a flux carrying stator that may be U-shaped in  
30 radial cross-section, and a radially wound electromagnetic magnetic coil extending into the recess defined by the U-shaped stator.

Furthermore, the first armature and the connecting bridge of the second armature have facing surfaces which may be provided with friction plates or meshing teeth.

The invention will now be described further with reference to an example of a clutch device according to the invention.

The figure shows a clutch device 1 in combination with a starter/generator device 2 only the front cap 3 of which is shown. The clutch device comprises a shaft 4 and a pulley 5 which is rotatable with respect to the shaft 4 in one direction only. This rotation between the shaft 4 and the pulley 5 is obtained by means of the one-way clutch 6 which in the present embodiment is carried out as a wrap spring. Other one-way clutches, such as with spragues, are possible as well. A bearing 19 is used to support the pulley on the shaft and allow rotation as dictated by the operation of the one-way clutch.

The starter/generator device shaft, which is not shown, is to be connected to the shaft 4 of the clutch device 1. For engine starting, torque must be transferred from the starter/generator device to engine. Since the one-way clutch 6 does not pass torque from starter/generator device to the engine, it must be temporarily locked-out to enable engine starting. This temporary lock-out is achieved by enabling the electromagnetic locking clutch 7 so that shaft 4 and pulley 5 are locked with no relative motion between them. Starting torque can then be transferred from the pulley 5 via the belt (not shown) to the internal combustion engine in question. This means that during the brief starting period there may be belt tension reversals.

The locking clutch 7 comprises a first armature 8 which is fixed on a sleeve 9. The sleeve 9 is axially slidable but non-rotatably fixed to the shaft 4 by means of the key/groove connection 10. A second armature 12 is fixedly connected to the pulley 1. Furthermore, the locking clutch comprises an electromagnetic actuator having a U-shaped stator 13 fixed through a bracket 18 to the front cap 3, as well as a coil 15 which fits within the recess of said stator 13. When the electromagnetic coil is energized a flux path 14 is created causing the first armature 8 together with sleeve 9 to be attracted towards the second armature 12. The facing surfaces 16 respectively 17 of the first armature 8 and the second armature 12 are provided with coupling means, for example friction plates or engaging teeth and as a result the pulley 5 is rigidly fixed to the shaft 4.

Once the internal combustion engine is started, the coil is de-energized and the first armature 8 is pushed out of contact with second armature 12 by a spring 11. The one-way clutch is thereby enabled and the starter/generator device now operates as a

generator. In this mode, the shaft 4 through the one-way clutch 6 rotates the pulley 5. The pulley 5 is connected to the internal combustion engine in question via a belt (not shown). The one-way clutch allows torque to pass from engine to starter/generator device, but does not let torque pass from starter/generator device to engine. In this way  
5 the one-way clutch operates in generator mode to eliminate belt tension reversals and improve belt life. Although the rotation member has been described as a pulley, other embodiments are possible as well such as a tooth gear or a toothed belt gear.

Claims

1. Clutch device (1), comprising a shaft (4), a rotation member, such as a pulley (5), which is coaxially mounted on said shaft (4), and a one-way clutch (6) for  
5 providing a freely rotatable condition when the shaft (4) and the rotation member (5) are rotated with respect to each other in a first relative rotational direction, and for providing a fixation between the shaft (4) and the rotation member (5) when they are rotated with respect to each other in the opposite relative rotational direction,  
10 characterized by a locking clutch (7) for providing a fixation between the shaft (4) and the rotation member (5), said locking clutch (7) preventing mutual rotations between the shaft (4) and the rotation member (5) in both relative rotational directions.

2. Clutch device according to claim 1, wherein the one-way clutch (6) comprises a wrap spring.  
15

3. Clutch device according to claim 1, wherein the one-way clutch (6) comprises a series of spragues.

4. Clutch device according to claim 1, wherein the one-way clutch (6) comprises a one way clutch bearing comprising locking rollers.  
20

5. Clutch device according to any of the preceding claims, wherein the locking clutch (7) is of an electromagnetic type.

25 6. Clutch device according to claim 5, wherein the locking clutch (7) comprises a first armature (8) which is axially slidably and rotationally fixed to the shaft (4) or the rotation member (5), and a second armature (12) which is fixedly connected to the other of said shaft (4) and rotation member (5), as well as friction means associated with said armatures (8, 12), said friction means frictionally engaging each other when  
30 the locking clutch (7) is energized.

7. Clutch device, comprising a shaft (4), a rotation member, such as a pulley (5), which is rotatably mounted on said shaft (4) and a one-way clutch (6) for providing a

freely rotatable condition when the shaft (4) and the rotation member (5) are rotated with respect to each other in a first relative rotational direction, and for providing a fixation between the shaft (4) and the rotation member (5) when they are rotated with respect to each other in the opposite relative rotational direction, characterized by a locking clutch (7) for providing a fixation between the shaft (4) and the rotation member (1), said locking clutch (7), when engaged, enabling direct torque transmission from the shaft (4) to the rotation member (5), the one-way clutch (6) being disabled.

8. Belt driven starter/generator device, comprising a starter/generator (2) provided with a housing (3), a stator (13) with coil (15) connected to the housing (3), and a rotor having a rotor shaft rotatably supported with respect to the housing (3), as well as a clutch device (1) according to any of the preceding claims, said clutch device comprising a rotation member (5), such as a pulley, which is rotatably mounted on the rotor shaft (4), and a one-way clutch (6) for providing a freely rotatable condition when the rotor shaft (4) and the rotation member (5) are rotated with respect to each other in a first relative rotational direction, and for providing a fixation between the rotor shaft (4) and the rotation member (5) when they are rotated with respect to each other in the opposite relative rotational direction, as well as a locking clutch (7) for providing a fixation between the rotor shaft (4) and the rotation member (5), said locking clutch (7) preventing mutual rotations between the rotor shaft (4) and the rotation member (5) in both relative rotational directions.

9. Starter/generator according to claim 8, wherein the locking clutch (7) comprises a first armature (8) which is axially slidably and rotationally fixed to the shaft (4) or the rotation member (1), a second armature (12) which is fixedly connected to the other of said shaft (4) and rotation member (5), an electromagnetic coil (18) connected to the housing (3) for generating an electromagnetic flux under the influence of which the armatures (8, 12) are attracted towards each other as well as coupling means (16, 17) associated with said armatures (8, 12), said coupling means engaging each other when the electromagnetic coil (18) is energized.



10. Starter/generator according to claim 9, wherein the rotation member (5) at its side facing the housing (3) carries the second armature (12), and the magnetic coil (18) extending next to said second armature (12).

5        11. Starter/generator according to claim 10, wherein the second armature (12) is an electromagnetic stator which is U-shaped in a radial cross-section, the electromagnetic coil (18) extending into the recess (20) defined by the U-shaped second armature (12).

10        12. Starter/generator according to any of claims 8-11, wherein the shaft (4) carries an axially displaceable sleeve (9) onto which the first armature (8) is mounted.

13. Starter/generator according to claim 12, wherein the first armature (8) is ring shaped and extends radially outwardly with respect to the sleeve (9).

15

14. Starter/generator according to any of claims 9-13, wherein the first armature (8) and the second armature (12) have facing surfaces (16, 17), said facing surfaces (16, 17) being provided with friction means or with teeth.

20        15. Starter/generator device according to any of claims 9-14, wherein biasing means (11) are provided for constantly urging the armatures (8, 12) away from each other.



# INTERNATIONAL SEARCH REPORT

PCT/NL2004/000052

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F16D41/04 F02N15/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16D F02N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 542 514 A (ITOH KENICHIRO ET AL) 6 August 1996 (1996-08-06) column 3, line 1 -column 4, line 61; figures 1-6	1,3,5,7
Y	US 2002/117860 A1 (REIK WOLFGANG ET AL) 29 August 2002 (2002-08-29) paragraph '0013! paragraph '0018! paragraph '0087! - paragraph '0092!; figures 1A,3	1,5,6,8, 9,14
Y	US 4 020 935 A (MORTENSEN HAROLD RICHARD) 3 May 1977 (1977-05-03) column 2, line 45 -column 3, line 7; figure 1	1,5,6,8, 9,14
	--- -/--	



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

27 April 2004

Date of mailing of the international search report

10/05/2004

Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Van Overbeeke, J

# INTERNATIONAL SEARCH REPORT

PCT/NL2004/000052

## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/025880 A1 (KITAMURA YUTAKA ET AL) 28 February 2002 (2002-02-28)  paragraph '0049! - paragraph '0055!; figure 1 -----	1,5, 8-11,14, 15
A	US 2 838 938 A (SACCHINI COLUMBUS R ET AL) 17 June 1958 (1958-06-17) column 2, line 49; figure 2 -----	2
A	US 2 951 570 A (ANTRIM JR WILLIAM DROWN ET AL) 6 September 1960 (1960-09-06) figures 1,2 -----	3
A	DE 100 57 516 A (MITSUBISHI ELECTRIC CORP) 22 November 2001 (2001-11-22) abstract -----	4

# INTERNATIONAL SEARCH REPORT

Information on patent family members

PCT/NL2004/000052

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 5542514	A	06-08-1996	JP 6344798 A JP 6344799 A DE 4420411 A1 FR 2706554 A1 GB 2278899 A , B	20-12-1994 20-12-1994 15-12-1994 23-12-1994 14-12-1994
US 2002117860	A1	29-08-2002	AU 1148700 A BR 9906937 A WO 0013927 A2 DE 19941705 A1 DE 19981672 D2 FR 2782959 A1 GB 2348630 A , B JP 2002525013 T	27-03-2000 03-10-2000 16-03-2000 16-03-2000 18-01-2001 10-03-2000 11-10-2000 06-08-2002
US 4020935	A	03-05-1977	DE 2629681 A1 FR 2316452 A1 GB 1534589 A JP 1082315 C JP 52006842 A JP 56021908 B	27-01-1977 28-01-1977 06-12-1978 29-01-1982 19-01-1977 22-05-1981
US 2002025880	A1	28-02-2002	JP 2002078286 A EP 1193836 A2	15-03-2002 03-04-2002
US 2838938	A	17-06-1958	NONE	
US 2951570	A	06-09-1960	CH 381029 A	15-08-1964
DE 10057516	A	22-11-2001	JP 2001317567 A DE 10057516 A1 FR 2808852 A1 US 6488135 B1	16-11-2001 22-11-2001 16-11-2001 03-12-2002